

**Listing of Claims:**

1. (Original) A method for rendering shadows comprising:  
determining visibility function of depth with respect to a given light source and  
object scene;  
storing said visibility function in a map location of a map; and  
rendering a geometric element for display, said rendering comprising:  
transforming said geometric element to yield one or more map locations  
and depths;  
  
evaluating said visibility function at said map locations and depths to yield  
a fractional light contribution from said light source.
2. (Original) The method of claim 1, wherein said geometric element is a  
surface.
3. (Original) The method of claim 1, wherein said geometric element is a  
volumetric primitive.
4. (Original) The method of claim 1, wherein said transforming said  
geometric element comprises projecting one or more sample points of said map locations from  
the camera's perspective to the coordinate system associated with said light source.
5. (Original) The method of claim 1, further comprising the step of  
compressing said visibility function.
6. (Original) The method of claim 1, wherein said storing said visibility  
function comprises storing a list of vertices.
7. (Original) The method of claim 6, wherein said evaluating said visibility  
function comprises performing a binary search of said list of vertices.
8. (Original) The method of claim 6, wherein said evaluating said visibility  
function comprises performing a linear search of said list of vertices.

9. (Original) The method of claim 8, wherein said performing a linear search comprises utilizing a pointer to initiate said search from one of said list of vertices most recently accessed in a prior search.

10. (Original) The method of claim 1, further comprising generating a plurality of resolutions of said map by averaging visibility functions of a plurality of adjacent map locations.

11. (Original) The method of claim 10, wherein said generating a plurality of resolutions further comprises compressing the result of said averaging.

12. (Original) The method of claim 1, further comprising storing a tile of map locations in a cache.

13. (Original) The method of claim 12, further comprising resizing a cache line of said cache in accordance with a tile size of said tile of map locations.

14. (Original) The method of claim 1, wherein said visibility function stores light attenuation information from a non point (i.e., area) light source.

15. (Original) A computer program product comprising:  
a computer readable medium having computer program code embodied therein for rendering shadows, said computer program code configured to cause a processor to:  
determine a visibility function of depth with respect to a given light source and object scene;  
store said visibility function in a map location of a map; and  
render a geometric element for display, wherein said render comprises:  
transforming said geometric element to yield one or more map locations and depths;  
evaluating said visibility function at said map locations and depths to yield a fractional light contribution from said light source.

16. (Previously Presented) A method for generating a shadow map, the method comprising:

receiving information associated with a first light source;  
generating at least a first ray and a second ray from the first light source;  
determining a first ray transmittance function associated with the first ray;  
determining a second ray transmittance function associated with the second ray;  
processing information associated with the first ray transmittance function and the second ray transmittance function;

determining a first visibility function based on at least information associated with the first ray transmittance function and the second ray transmittance function;

wherein the determining a first ray transmittance function includes:

processing information associated with the first ray;  
determining at least a first surface transmittance function based on at least information associated with the first ray;  
determining at least a first volume transmittance function based on at least information associated with the first ray;  
processing information associated with the first surface transmittance function and the first volume transmittance function;  
determining the first ray transmittance function based on at least information associated with the first surface transmittance function and the first volume transmittance function.

17. (Previously Presented) The method of claim 16 wherein the determining at least a first volume transmittance function comprises:

processing information associated with the first ray;  
determining a first volumetric element intersecting the first ray;  
processing information associated with the first volumetric element;  
determining the first volume transmittance function based on at least information associated with the first volumetric element.

18. (Previously Presented) The method of claim 16 wherein the determining at least a first surface transmittance function comprises:

- processing information associated with the first ray;
- determining a first surface element intersecting the first ray;
- processing information associated with the first surface element;
- determining the first surface transmittance function based on at least information associated with the first surface element.

19. (Previously Presented) The method of claim 16, and further comprising:  
compressing the first visibility function to generate a second visibility function;  
storing the second visibility function in a shadow map.

20. (Previously Presented) The method of claim 19 wherein a first difference between the first visibility function and the second visibility function is larger than or equal to a first predetermined value and smaller than or equal to a second predetermined value.

21. (Previously Presented) The method of claim 19 wherein the shadow map includes the second visibility function with respect to a first three-dimensional coordinate system, the first three-dimensional system associated with the first light source.

22. (Previously Presented) The method of claim 16 wherein the first visibility function is capable of being equal to any value smaller than or equal to a first value and larger than or equal to a second value, the first value associated with being fully lit by the first light source, and the second value associated with being completely unlit by the first light source.

23. (Previously Presented) The method of claim 16, and further comprising:  
determining a first map plane associated with the first light source;  
processing information associated with the first map plane;  
determining a first sample region on the first map plane;

wherein each of the first ray and the second ray intersects the first map plane within the first sample region.

24. (Previously Presented) The method of claim 16 wherein the first visibility function is associated with a plurality of values corresponding to a first location with respect to a first three-dimensional coordinate system, the first three-dimensional system associated with the first light source.

25. (Previously Presented) The method of claim 24 wherein the plurality of values are associated with a plurality of colors respectively.

26. (Previously Presented) The method of claim 16 wherein the first light source is an area light source.

27. (Previously Presented) The method of claim 16 wherein the first light source is a point light source.

28. (Previously Presented) A method for generating a shadow map, the method comprising:

- receiving information associated with a first light source;
- generating at least a first ray and a second ray from the first light source;
- determining a first ray transmittance function associated with the first ray;
- determining a second ray transmittance function associated with the second ray;
- processing information associated with the first ray transmittance function and the second ray transmittance function;

- determining a first visibility function based on at least information associated with the first ray transmittance function and the second ray transmittance function;

- wherein the determining a first ray transmittance function includes:

determining a first geometric element intersecting the first ray;  
processing information associated with the first geometric element;  
determining a first geometric transmittance function based on at least  
information associated with the first geometric element;  
processing information associated with first geometric transmittance  
function;  
determining the first ray transmittance function based on at least  
information associated with first geometric transmittance function.

29. (Previously Presented) The method of claim 28 wherein the geometric element is a surface element.

30. (Previously Presented) The method of claim 28 wherein the geometric element is a volumetric element.

31. (Previously Presented) A method for generating a shadow map, the method comprising:

receiving information associated with a first light source;  
generating at least a first ray and a second ray from the first light source;  
determining a first ray transmittance function associated with the first ray;  
determining a second ray transmittance function associated with the second ray;  
processing information associated with the first ray transmittance function and the  
second ray transmittance function;

determining a first visibility function based on at least information associated with  
the first ray transmittance function and the second ray transmittance function;

wherein the first visibility function is capable of being equal to any value smaller  
than or equal to a first value and larger than or equal to a second value, the first value associated  
with being fully lit by the first light source, and the second value associated with being  
completely unlit by the first light source.

32. (Previously Presented) The method of claim 31 wherein the determining a first ray transmittance function associated with the first ray comprises:

- processing information associated with the first ray;
- determining a first geometric element intersecting the first ray;
- processing information associated with the first geometric element;
- determining the first geometric transmittance function based on at least information associated with the first geometric element.

33. (Previously Presented) The method of claim 31, and further comprising:

- compressing the first visibility function to generate a second visibility function;
- storing the second visibility function in a shadow map.

34. (Previously Presented) The method of claim 33 wherein a first difference between the first visibility function and the second visibility function is larger than or equal to a first predetermined value and smaller than or equal to a second predetermined value.

35. (Previously Presented) The method of claim 33 wherein the shadow map includes the second visibility function with respect to a first three-dimensional coordinate system, the first three-dimensional system associated with the first light source.

36. (Previously Presented) The method of claim 31 wherein the determining a first ray transmittance function associated with the first ray comprises determining ray attenuation associated with at least a first geometric element.

37. (Previously Presented) The method of claim 36 wherein the first geometric element is a surface element.

38. (Previously Presented) The method of claim 36 wherein the geometric element is a volumetric element.

39. (Previously Presented) The method of claim 31, and further comprising:

- determining a first map plane associated with the first light source;

processing information associated with the first map plane;  
determining a first sample region on the first map plane;  
wherein each of the first ray and the second ray intersects the first map plane within the first sample region.

40. (Previously Presented) The method of claim 31 wherein the first visibility function is associated with a plurality of values corresponding to a first location with respect to a first three-dimensional coordinate system, the first three-dimensional system associated with the first light source.

41. (Previously Presented) The method of claim 40 wherein the plurality of values are associated with a plurality of colors respectively.

42. (Previously Presented) The method of claim 31 wherein the first light source is an area light source.

43. (Previously Presented) The method of claim 31 wherein the first light source is a point light source.

44. (Previously Presented) A method for rendering an object, the method comprising:

receiving information associated with a first shadow map related to a first light source, the first shadow map including a first visibility function with respect to a first three-dimensional coordinate system;

receiving information associated with a first surface;

determining a first location associated with the first surface with respect to the first three-dimensional coordinate system;

processing information associated with the first location and the first shadow map;

determining a first visibility value associated with the first location based on at least information associated with the first shadow map and the first location;



wherein the first visibility value is capable of being equal to any value smaller than or equal to a first value and larger than or equal to a second value, the first value being associated with being fully lit by the first light source, and second value being associated with being completely unlit by the first light source.

45. (Previously Presented) The image formed according to the method of claim 44.

46. (Previously Presented) A method for rendering an object, the method comprising:

receiving information associated with a first shadow map related to a first light source, the first shadow map including a first visibility function with respect to a first three-dimensional coordinate system;

receiving information associated with a first surface;

determining a first location associated with the first surface with respect to the first three-dimensional coordinate system;

processing information associated with the first location and the first shadow map;

determining a first visibility value associated with the first location based on at least information associated with the first shadow map and the first location;

wherein the first visibility value is associated with at least a first geometric transmittance function.

47. (Previously Presented) The image formed according to the method of claim 46.

48. (Previously Presented) A computer program product including a computer-readable medium including instructions for generating a shadow map, the computer-readable medium comprising:

one or more instructions for receiving information associated with a first light source;

one or more instructions for generating at least a first ray and a second ray from the first light source;

one or more instructions for determining a first ray transmittance function associated with the first ray;

one or more instructions for determining a second ray transmittance function associated with the second ray;

one or more instructions for processing information associated with the first ray transmittance function and the second ray transmittance function;

one or more instructions for determining a first visibility function based on at least information associated with the first ray transmittance function and the second ray transmittance function;

wherein the one or more instructions for determining a first ray transmittance function includes:

one or more instructions for processing information associated with the first ray;

one or more instructions for determining at least a first surface transmittance function based on at least information associated with the first ray;

one or more instructions for determining at least a first volume transmittance function based on at least information associated with the first ray;

one or more instructions for processing information associated with the first surface transmittance function and the first volume transmittance function;

one or more instructions for determining the first ray transmittance function based on at least information associated with the first surface transmittance function and the first volume transmittance function.

49. (Previously Presented) A computer program product including a computer-readable medium including instructions for generating a shadow map, the computer-readable medium comprising:

one or more instructions for receiving information associated with a first light source;

one or more instructions for generating at least a first ray and a second ray from the first light source;

one or more instructions for determining a first ray transmittance function associated with the first ray;

one or more instructions for determining a second ray transmittance function associated with the second ray;

one or more instructions for processing information associated with the first ray transmittance function and the second ray transmittance function;

one or more instructions for determining a first visibility function based on at least information associated with the first ray transmittance function and the second ray transmittance function;

wherein the one or more instructions for determining a first ray transmittance function includes:

one or more instructions for determining a first geometric element intersecting the first ray;

one or more instructions for processing information associated with the first geometric element;

one or more instructions for determining a first geometric transmittance function based on at least information associated with the first geometric element;

one or more instructions for processing information associated with first geometric transmittance function;

one or more instructions for determining the first ray transmittance function based on at least information associated with first geometric transmittance function.

50. (Previously Presented) A computer program product including a computer-readable medium including instructions for generating a shadow map, the computer-readable medium comprising:

- one or more instructions for receiving information associated with a first light source;

- one or more instructions for generating at least a first ray and a second ray from the first light source;

- one or more instructions for determining a first ray transmittance function associated with the first ray;

- one or more instructions for determining a second ray transmittance function associated with the second ray;

- one or more instructions for processing information associated with the first ray transmittance function and the second ray transmittance function;

- one or more instructions for determining a first visibility function based on at least information associated with the first ray transmittance function and the second ray transmittance function;

- wherein the first visibility function is capable of being equal to any value smaller than or equal to a first value and larger than or equal to a second value, the first value associated with being fully lit by the first light source, and the second value associated with being completely unlit by the first light source.

51. (Previously Presented) A computer program product including a computer-readable medium including instructions for rendering an object, the computer-readable medium comprising:

- one or more instructions for receiving information associated with a first shadow map related to a first light source, the first shadow map including a first visibility function with respect to a first three-dimensional coordinate system;

- one or more instructions for receiving information associated with a first surface;

one or more instructions for determining a first location associated with the first surface with respect to the first three-dimensional coordinate system;

one or more instructions for processing information associated with the first location and the first shadow map;

one or more instructions for determining a first visibility value associated with the first location based on at least information associated with the first shadow map and the first location;

wherein the first visibility value is capable of being equal to any value smaller than or equal to a first value and larger than or equal to a second value, the first value being associated with being fully lit by the first light source, and second value being associated with being completely unlit by the first light source.

52. (Previously Presented) A computer program product including a computer-readable medium including instructions for rendering an object, the computer-readable medium comprising:

one or more instructions for receiving information associated with a first shadow map related to a first light source, the first shadow map including a first visibility function with respect to a first three-dimensional coordinate system;

one or more instructions for receiving information associated with a first surface;

one or more instructions for determining a first location associated with the first surface with respect to the first three-dimensional coordinate system;

one or more instructions for processing information associated with the first location and the first shadow map;

one or more instructions for determining a first visibility value associated with the first location based on at least information associated with the first shadow map and the first location;

wherein the first visibility value is associated with at least a first geometric transmittance function.

53. (Previously Presented) A system for generating a shadow map, the system comprising:

a processing system configured to:

- receive information associated with a first light source;
- generate at least a first ray and a second ray from the first light source;
- determine a first ray transmittance function associated with the first ray;
- determine a second ray transmittance function associated with the second

ray;

- process information associated with the first ray transmittance function and the second ray transmittance function;

- determine a first visibility function based on at least information associated with the first ray transmittance function and the second ray transmittance function;

- wherein the determine a first ray transmittance function includes:

- process information associated with the first ray;

- determine at least a first surface transmittance function based on at least information associated with the first ray;

- determine at least a first volume transmittance function based on at least information associated with the first ray;

- process information associated with the first surface transmittance function and the first volume transmittance function;

- determine the first ray transmittance function based on at least information associated with the first surface transmittance function and the first volume transmittance function.

54. (Previously Presented) A system for generating a shadow map, the system comprising:

a processing system configured to:

- receive information associated with a first light source;

generate at least a first ray and a second ray from the first light source;  
determine a first ray transmittance function associated with the first ray;  
determine a second ray transmittance function associated with the second ray;

process information associated with the first ray transmittance function and the second ray transmittance function;

determine a first visibility function based on at least information associated with the first ray transmittance function and the second ray transmittance function;

wherein the determine a first ray transmittance function includes:

determine a first geometric element intersecting the first ray;  
process information associated with the first geometric element;  
determine a first geometric transmittance function based on at least information associated with the first geometric element;  
process information associated with first geometric transmittance function;

determine the first ray transmittance function based on at least information associated with first geometric transmittance function.

55. (Previously Presented) A system for generating a shadow map, the system comprising:

a processing system configured to:

receive information associated with a first light source;  
generate at least a first ray and a second ray from the first light source;  
determine a first ray transmittance function associated with the first ray;  
determine a second ray transmittance function associated with the second ray;

process information associated with the first ray transmittance function and the second ray transmittance function;

determine a first visibility function based on at least information associated with the first ray transmittance function and the second ray transmittance function;

wherein the first visibility function is capable of being equal to any value smaller than or equal to a first value and larger than or equal to a second value, the first value associated with being fully lit by the first light source, and the second value associated with being completely unlit by the first light source.

56. (Previously Presented) A system for rendering an object, the system comprising:

a processing system configured to:

receive information associated with a first shadow map related to a first light source, the first shadow map including a first visibility function with respect to a first three-dimensional coordinate system;

receive information associated with a first surface;

determine a first location associated with the first surface with respect to the first three-dimensional coordinate system;

process information associated with the first location and the first shadow map;

determine a first visibility value associated with the first location based on at least information associated with the first shadow map and the first location;

wherein the first visibility value is capable of being equal to any value smaller than or equal to a first value and larger than or equal to a second value, the first value being associated with being fully lit by the first light source, and second value being associated with being completely unlit by the first light source.

57. (Previously Presented) A system for rendering an object, the system comprising:

a processing system configured to:



receive information associated with a first shadow map related to a first light source, the first shadow map including a first visibility function with respect to a first three-dimensional coordinate system;

receive information associated with a first surface;

determine a first location associated with the first surface with respect to the first three-dimensional coordinate system;

process information associated with the first location and the first shadow map;

determine a first visibility value associated with the first location based on at least information associated with the first shadow map and the first location;

wherein the first visibility value is associated with at least a first geometric transmittance function.